



SIWG Phase 3

Recommendations for Advanced Functions for Distributed Energy Resources (DER) Systems

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Smart Inverter Working Group (SIWG)

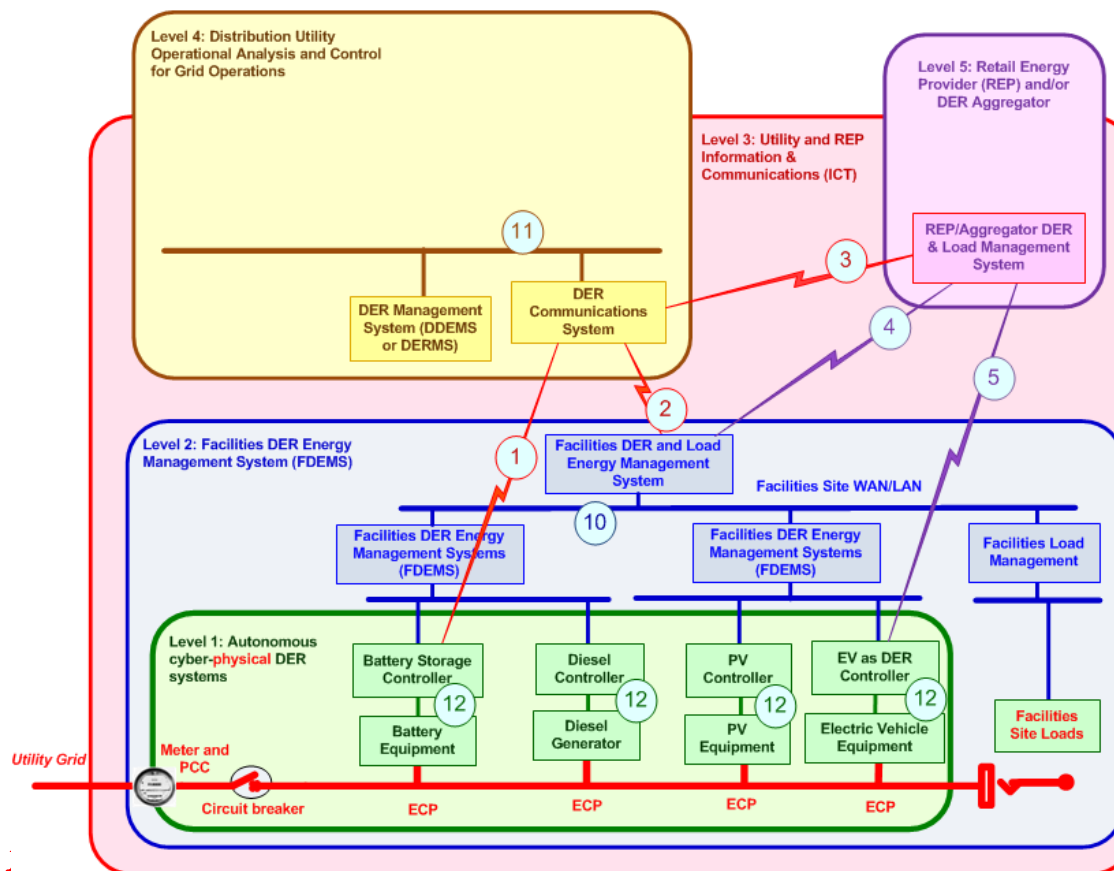
- The CPUC and the CEC staff convened the Smart Inverter Working Group (SIWG) in January 2013 to:
 - Discuss the emerging technical possibilities for DER systems
 - Develop the default DER functionality requirements
 - Establish an implementation plan for California
 - Update California's Rule 21 on DER interconnection requirements
- The SIWG currently has over 200 participants from all major stakeholder groups, including utilities, inverter manufacturers, integrators, customer groups, investors, and interested parties.
- The SIWG developed a phased approach:
 - Phase 1: Seven (7) critical autonomous functions
 - Phase 2: Communications capabilities for monitoring, updating settings, and control
 - Phase 3: Additional DER functions
- This California effort and other initiatives have triggered the updating of IEEE 1547, first to 1547a to permit these functions, and now to a complete update of 1547

Phase 1: Seven Autonomous DER Functions

- SIWG Recommendations for Phase 1 Functions:
 - Support anti-islanding to trip off under extended anomalous conditions, coordinated with the following functions.
 - Provide ride-through of low/high voltage excursions beyond normal limits.
 - Provide ride-through of low/high frequency excursions beyond normal limits.
 - Provide volt/var control through dynamic reactive power injection through autonomous responses to local voltage measurements.
 - Define default and emergency ramp rates as well as high and low limits.
 - Provide reactive power by a fixed power factor.
 - Reconnect by “soft-start” methods (e.g. ramping and/or random time within a window).
- CPUC commissioners approved these SIWG recommendations on December 18, 2014, with IOU filings in January 2015. They will be mandatory for all new inverter-based systems by mid- 2016
 - UL 1741 is being updated to provide testing and certification for these functions, and is *almost* ready for ballot
 - IEEE 1547 is being updated using many of California’s requirements but expanded for a broader basis and focused on standard’s requirements

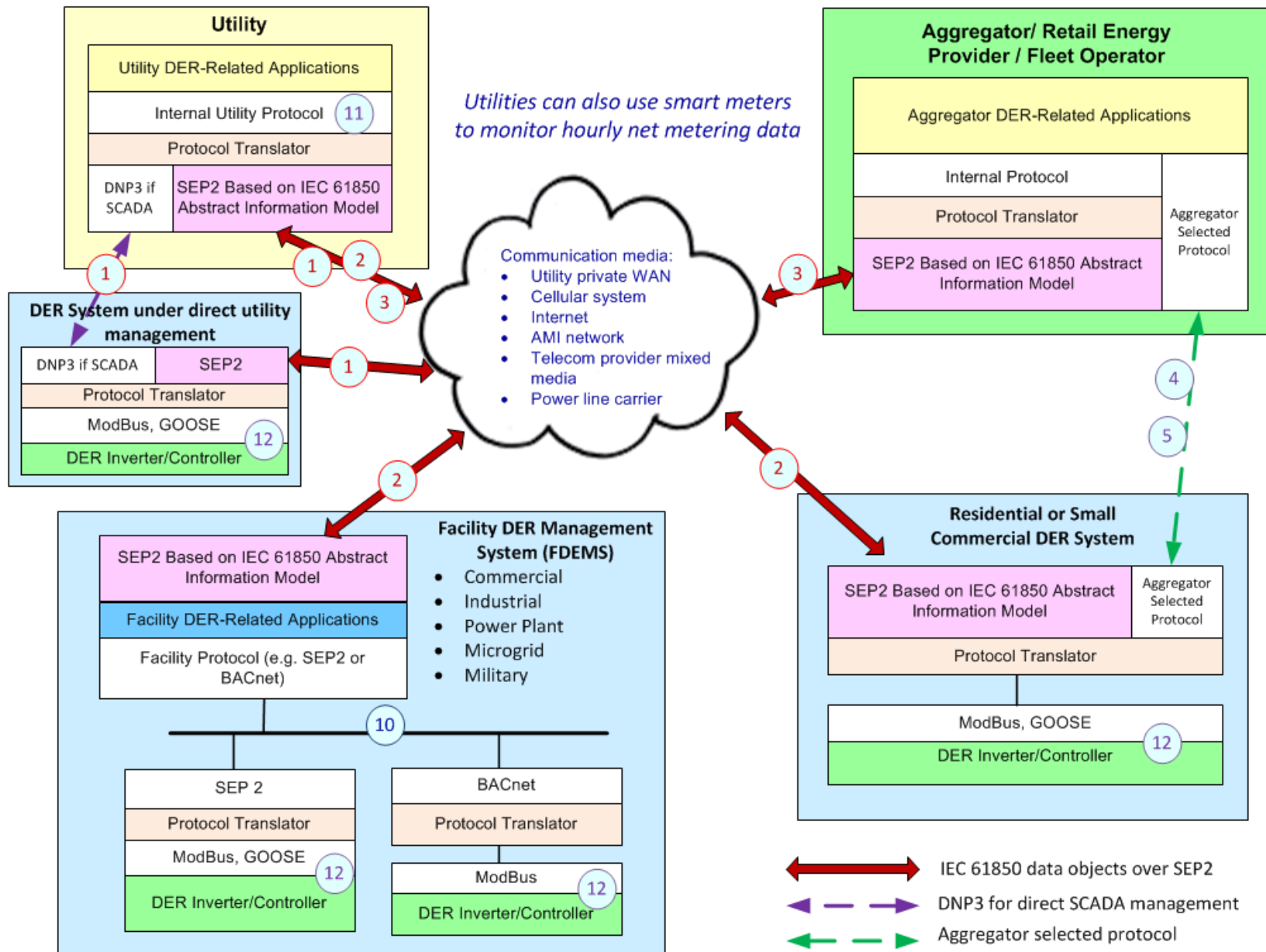
Scope of SIWG Phase 2

- Communications between utilities and 3rd parties (see red lightning bolts):
 - (1) Utilities to DER Systems
 - (2) Utilities to Facility Energy Management Systems
 - (3) Utilities to Aggregators



DER Configurations, SEP2, DNP3, and Other Protocols

Example Configurations for Smart Energy Profile (SEP 2) and DNP3 as Communications Protocols between Utilities and other Parties



California's Law AB 327 and Distribution Resources Plans (DRP)

- California's Law AB 327 requires Distribution Resources Plans (DRP) from each of the large California utilities
- These DRPs are expected to define (electrical) locational benefits and optimal locations for DER systems, to develop augmented or new tariffs and programs to support efficient DER deployment, and to remove specific barriers to deployment of DER systems.
- **The DRPs will eventually include the use of the “smart inverter” functionalities**, identifying where some of the functions (e.g. volt-var control) would be expected to be needed to ensure safe, reliable, and efficient distribution operations

Phase 3 Tasks

- Review Phase 3 functions
 - Are all important ones included or should additional ones be added?
 - Which are rated High, Medium, or Optional?
- Which functions require additional electrical and/or timing requirements or constraints?
 - Frequency-watt?
 - Voltage-watt?
 - Dynamic Current Support?
 - Scheduling of output and functions?
 - Energy storage management and scheduling?
 - Frequency support such as frequency smoothing or AGC?
- Which requirements should go into Rule 21?
 - Rule 21?
 - Utility Handbook?
 - Mutual utility-customer-vendor agreement?



**See Word Document of Phase
3 Functions**

#1 Phase 3 Advanced DER Functions (Utility H/M/L Ratings)

- Monitoring and control
 - Utility monitors, updates settings, and issues controls to DER system, FDEMS, microgrid, or group of aggregator-managed DER systems (*see Phase 2 for default data exchanges*)
 - Real power output at the PCC is limited to a maximum value by the DER owner/operator. This information must be provided to the utility. (H)
- Real Power DER Functions
 - The utility limits the maximum real power output at the PCC by a command to the DER system, the facility energy management system, or the aggregator who manages the DER system. (H)
 - The utility sets the actual real power output at the PCC if permitted by tariff agreements. (M)
 - The utility schedules the actual real power output or limits the maximum real power output at the PCC for specific time periods. (H)
 - The utility sets the voltage-watt parameters for the DER system to modify its real power output autonomously in response to local voltage variations. (H)
 - The utility sets or schedules the storage of energy for later delivery, indicating time to start charging, charging rate and/or “charge-by” time. (Applicable for energy storage; NA for PV systems)
- Reactive Power DER Functions
 - The utility sets a fixed power factor parameter for the DER system (having a fixed power factor is a Phase 1 capability; updating the power factor is a Phase 3 capability). (H)
 - The utility sets the curves for volt-var control for the DER system to provide dynamic reactive power injection through autonomous responses to local voltage measurements (volt-var control is a Phase 1 function; updating the volt-var curves is a Phase 3 capability). (H)
 - The utility provides and/or updates the temperature/current/time-of-day var curves for the DER system to provide reactive power through autonomous responses to temperature, current, or time-of-day. (H for temperature)

#2 Phase 3 Advanced DER Functions

- Frequency Support DER Functions
 - Utility uses DER systems for frequency regulation by setting the curves for the DER systems to autonomously and rapidly modify real power output to counter minor frequency deviations. The utility can enable/disable the function. (H)
 - Utility uses DER systems for frequency regulation by issuing automatic generation control (AGC) commands. (M)
- DER Response to Emergencies
 - Utility issues commands to the DER system to disconnect or reconnect. (M)
 - Utility updates the voltage ride-through curves to change the anti-islanding settings (voltage ride-through is a Phase 1 function; updating the curves is a Phase 3 capability). (H)
 - Utility updates the frequency ride-through curves to change the anti-islanding settings (frequency ride-through is a Phase 1 function; updating the curves is a Phase 3 capability). (H)
 - Utility receives notification that a microgrid disconnected or reconnected from the utility grid. (L)
 - Utility issues a command to disconnect or reconnect a microgrid from the utility grid. (L)
 - Utility requests that the DER system provide “spinning” or operational reserve, as bid into the ancillary services market
- Scheduling DER Output, Modes, and/or Functions
 - Utility provides schedules for real power settings, reactive settings, real power or reactive power limits, power factors, ancillary services bid into market, activating/deactivating modes, and other operational settings. Schedules may be for specific time periods or may repeat periodically, e.g. daily, weekly, seasonally. Multiple schedules may be in effect so long as they do not conflict. Higher priority schedules preempt lower priority schedules.
 - Utilities activate/deactivate schedules
 - Utility receives schedules from DER systems that forecast their net real power and storage schedules.

Examples of Use Cases for Different Interaction Scenarios

1. Utility monitors, updates settings, and issues controls to an individual DER system that is (contractually) under utility management
2. Utility monitors, updates settings, and issues controls to a DER power plant that is (contractually) under utility management
3. Utility monitors, updates settings, and issues controls to a facility (commercial, industrial, DER power plant, or residential) that manages its own DER systems
4. Utility monitors, updates settings, and issues controls to an Aggregator that manages the DER systems under its own contracts
5. Utility has an emergency event that autonomous DER systems CAN “see” and have been enabled to respond autonomously to it (e.g. local voltage or frequency anomaly)
6. Utility has an emergency event that DER systems CANNOT “see” locally (e.g. possible distribution transformer overload or transmission system needs vars or assistance in frequency control (AGC))
7. Utility wants a snapshot from all DER (individual or aggregated) to use in planning (e.g. small time skew with large number of DER reporting)
8. Fault Location, Isolation, Reconfiguration (FLISR) event requires rapid updates of DER settings
9. Utility monitors renewable power plant and compensates for fluctuations by issuing control commands to an energy storage facility located elsewhere
10. Microgrid “warns” utility of intentional islanding or reconnection
11. Utility “warns” microgrids of impending emergency situation that might warrant islanding
12. Utility “discovers” a DER system or facility after interconnection approval and installation
13. Other?



Slides used in previous calls

The information from these slides and the discussions are being used for the document that will eventually be turned into the CPUC: “SIWG Phase 3 Recommendations for Rule 21”

They are maintained in this slide deck so that they are available to be seen